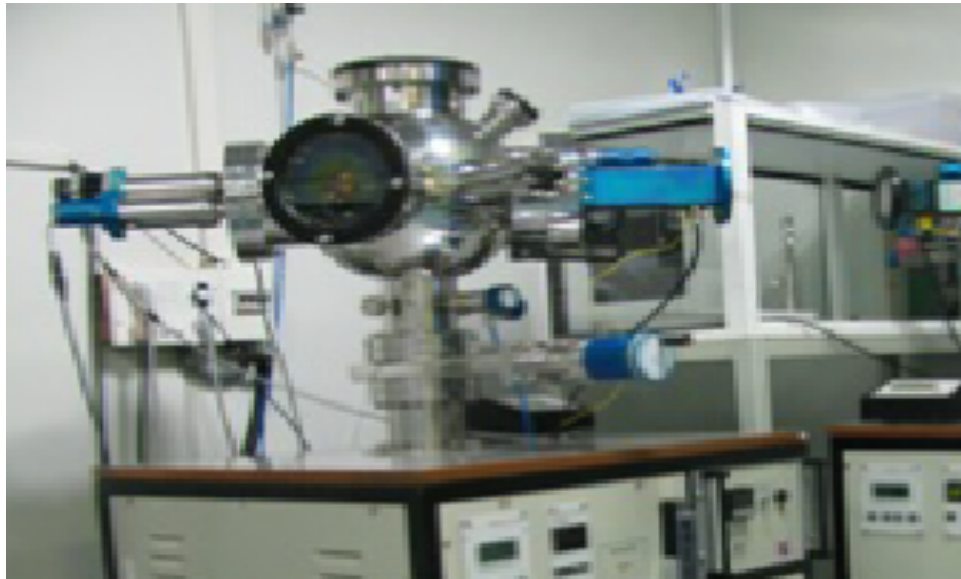


Standard Operating Procedure [SOP]

Pulse LASER Deposition system-II



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(A) System turn ON: Pre-deposition

External checks – In the service corridor:

- Turn on laser exhaust [Furnace exhaust].
- Turn on pump exhaust [ICPCVD, RTP side].
- Start cooling water flow, set it between 3 to 5 lpm.
- Check O2 cylinder pressure. If the pressure is less than 10 kg/cm², the cylinder may need to be replaced.
- Turn on the service corridor AC.

At the system (inside clean room):

- Pull the chamber valve to vent the chamber completely. The chamber comes to atmospheric pressure and the sample holder-heater can now be removed.
- Mount the target onto one of the holding rods/pins of the target carousel inside the chamber (screw it in with the 2.5 gauge allen key).
- Measure and set the substrate-target distance as desired.
- Place the reflecting mirror in the position marked inside the laser box. Make sure that the reflecting side is facing the laser.
- Rotate the target carousel so as to position the target center approximately in line with the substrate holder center.
- Switch ON KrF laser – Turn on the main wall MCB switch (to which the laser is plugged), rotate laser's red knob to ON position (vertical).
- Set the following parameters on the laser keypad:

Mode = HV NGR
HV = 18 kV
Frequency = 1 Hz

- Open laser shutter and the pass-box shutter. Position the desired aperture in place.
- Start the laser shots and check if they are hitting the target at its center. If not, one can tune the mirror placement in X/Y/Z direction accordingly.
- Note the start and end angles on the carousel for raster scan of the target using angle controller.

- Place a small piece of an x-ray sheet in front of the target and capture multiple laser shots at different spots. Use any one well-defined spot to measure the laser spot size. Turn off the laser.
- With the measured spot size (SS), and known energy density (ED) and laser repetition rate (RR) for deposition, calculate the required laser energy density for deposition.
- Hold the laser power meter inside the chamber, facing the laser window. Make sure the initial offset power is nulled (zero).
- Set the desired RR value on the key pad. Turn on the laser.
- In the HV NGR mode, move from HV = 18 kV to HV = 26 kV systematically in steps of 2 kV and repetition rate take from 1-10Hz but for HV=27kV repetition rate should not more than 5Hz (In this case you can change voltage and frequency); and note the HV and EGY value at which the desired energy is obtained (In this case you change energy and frequency). Turn off the laser followed by laser change in HV NGR mode always.
- Set the following parameters on the laser keypad:

Mode = EGY NGR
 EGY = value noted in step 14.
 Frequency = RR value used in steps 13 and 14.
 Trigger = as desired (INT or EXT)

- Place the substrate on the sample holder – it can be either held in place using a clip or stuck to the holder using Ag paste (200 °C, ramp time 10 min+constant for 5 min) or both.
- Set the temperature ramp program for the desired substrate temperature for deposition.
- Position the sample shutter in place and load the sample holder into the chamber. Make sure that the holder is loaded tight, without any leaks. Once it is loaded, rotate the shutter away from the sample (to avoid the shutter from getting heated, especially for very high temperature depositions).
- Open the column chamber valve – make sure that the column line is completely vented. Close the valve back tightly.
- Partially open the gate valve.
- Switch on the rotary pump and pressure gauge. Once the pressure is seen to drop, open the gate valve completely.
- When the pressure drops below 2e-2 mbar, switch on the turbo pump.
- Make sure that the turbo is in 'standby ON' mode. Wait for it to attain standby speed (660 Hz).
- When it is stabilized at standby speed, put the turbo in 'standby OFF' mode. It now ramps to its maximum speed (1000 Hz).
- Wait for the chamber pressure to drop below 7e-5 mbar. This takes at least 1.5 hours of turbo operation at full speed.

- Simultaneously, the substrate temperature ramps to the set desired value.
- Switch on the target carousel box – feed the current angle. The carousel adjusts to 0° angle using current position. Then feed in the target deposition parameters – start angle, end angle, total no. of shots (including pre-ablation shots), scan frequency, target frequency, DC motor ON. (set frequency and target frequency always keep same)
- Once the pre-deposition vacuum and substrate temperature is attained, partially close the gate valve and put the turbo pump in ‘standby ON’ mode. (In case of oxide sample)
- Check if all the deposition parameters are correctly fed – both in the laser keypad and the target carousel box.
- Position the sample shutter in front of the sample.
- Open the O_2 line valve. Set the process gas knob (flow meter) on the system to ‘control’ position. Maintain flow to the chamber between 20 to 40 sccm using the flow-meter.
- Open the inlet valve slowly in a controlled manner. There may be a sudden pressure rise inside the chamber due to the introduction of O_2 . Using gate valve, set and control the pressure inside the chamber within the desired process pressure range.
- Once the process pressure value is attained, start the laser. Use goggle, Keep an eye on the shots being measured.
- After the pre-ablation shots are done, remove the shutter away from the sample and let the deposition begin.
- Maintain the desired process gas pressure throughout the deposition by adjusting the gate valve position/flowmeter.

(B) System turn OFF: Post-deposition

- Once the deposition is completed, press ‘BREAK’ on the laser keypad to switch off the laser.
- Completely close the gate valve.
- Vent the chamber with O_2 until the desired cooling pressure is obtained.
- Close all the process gas valves – inlet valve, process gas knob and O_2 line valve.
- Switch of the temperature PID controller or start the substrate cooling ramp-down as desired.
- Set the following parameters on the laser keypad:

Mode = HV NGR
 HV = 18 kV
 Frequency = 1 Hz

- Press ‘F10-Enter-EXEC’ to completely shut down the laser.

- Switch off the target carousel control box.
- Switch off the turbo pump.
- Once it is completely off (0 Hz), switch off the rotary pump.
- Immediately open the column chamber valve to vent the column line.

External checks – In the service corridor:

- Switch OFF KrF laser supply – first, rotate laser’s red knob to OFF position (horizontal) and then, turn off the main wall MCB switch (to which the laser is plugged).
- Close the laser shutter and the pass box shutter.
- Turn off the service corridor AC, if not required by anyone else.
- Stop cooling water flow - close the valve.

Table 1: **System Handover Protocol.**

At the beginning of slot	At the end of slot
<ul style="list-style-type: none"> • Remove the heater connections from the base of the sample holder. Take the sample holder into the service corridor and scrub it thoroughly with fine emery paper/ scotch brite to remove coatings of previous depositions. Make sure to scrub the radiation shield, shutter, and sample clip that would be used in your slot. • Clean the chamber inner walls, target holder slot and base plate with IPA. • Remove your samples and target from the chamber. 	<ul style="list-style-type: none"> • Remove your samples and target from the chamber. • Wipe the chamber inner walls and heater surface with IPA. • Load the sample holder and pump down the chamber pressure to below 7e-4 mbar. Maintaining the system in vacuum is essential when the system is not in use. • Close the gate valve completely before turning off both the turbo and rotary pumps. • Vent the column chamber valve. The column chamber should always be at atmospheric pressure when the system is not in use.